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CONTRIBUTIONS FROM THE BERMUDA BIOLOGICAL STATION FOR RESEARCH. Nos. 142 AND 143.

No. 11. MARINE BORERS IN BERMUDA.

By E. L. Mark

With Four Plates.

No. 12. NEW SPECIES OF SHIPWORMS IN BERMUDA.

By W. F. Clapp.

With Three Plates.

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CONTRIBUTIONS FROM THE BERMUDA BIOLOGICAL STATION FOR RESEARCH. No. 142.

MARINE BORERS IN BERMUDA.

By E. L. Mark

With Four Plates.

CONTRIBUTIONS FROM THE BERMUDA BIOLOGICAL STATION FOR RESEARCH. NO. 142.

MARINE BORERS IN BERMUDA.

By E. L. Mark.

Received March 29, 1924. Presented November 14, 1923.

The sudden collapse of certain docks in San Francisco Bay in 1919 and 1920, due to the boring of the piles by "shipworms," sharply called the attention of the shipping interests of the region to the necessity of finding out more than was then known about the life-history and habits of marine "borers," and of devising, if possible, better means of protection from them than had been hitherto used, for the loss due to such destruction, actual and threatened, amounted to several million dollars. The importance of the matter naturally stimulated the corresponding interests of the Atlantic ports to institute inquiries regarding conditions on the eastern coast of the United States.

Several agencies, chiefly engineering, carried on investigations in one or more directions, but early in 1922 the National Research Council appointed a "Committee on Marine Piling Investigations," which was organized under the joint control of two of its divisions, those of Engineering and of Biology and Agriculture. The purpose of the Council in appointing this Committee was to secure the coöperation of a large number of scientific and commercial organizations in support of a comprehensive plan involving the study of existing conditions, and experimentation as to possible means of controlling the pests, or protecting piling from their destructive work, along the whole United States coastline.

Knowing that these investigations into the life-history, distribution, depredations, etc. of Teredo and other marine "borers" were already being carried on under the auspices of the Council, it seemed to me in the summer of 1922 that the study of the conditions in Bermuda might be of some value for comparison with those on our own Atlantic seaboard. Accordingly, I got into communication with Colonel William G. Atwood, in New York, Chairman of the Committee having these investigations in hand, with a view to aiding in the work.

The present brief statement may serve as an introduction to the

more important results which, it is hoped, will follow from the study of Bermudian material.

There are not many places in Bermuda where considerable wooden structures accessible to borers are still left, the former wooden piers and landings having been mostly replaced by concrete. There is left, however, some evidence of earlier activities, one or two instances of which are shown in the accompanying illustrations (Figs. 1–8, pls. I–IV). At Pitt's Bay, near Hamilton, a dock supported by wooden piles was built by Mr. H. C. Masters in 1914. Mr. Masters, to whom I am indebted for helpful suggestions in this whole inquiry, has furnished the following information about the piling.

"The wood of the piling is South African black oak; it came out of an old British wooden warship, built in Lord Nelson's time. This wood had been under water for about twenty years before I used it as piling, so that it has now (1923) been in the water a total of about twenty-nine years. It was not protected when used as piling. The piles are now pretty well bored through by the Teredo. I judge that about two thirds of the wood has been destroyed. I do not see any signs of the Limnoria making any attack at all."

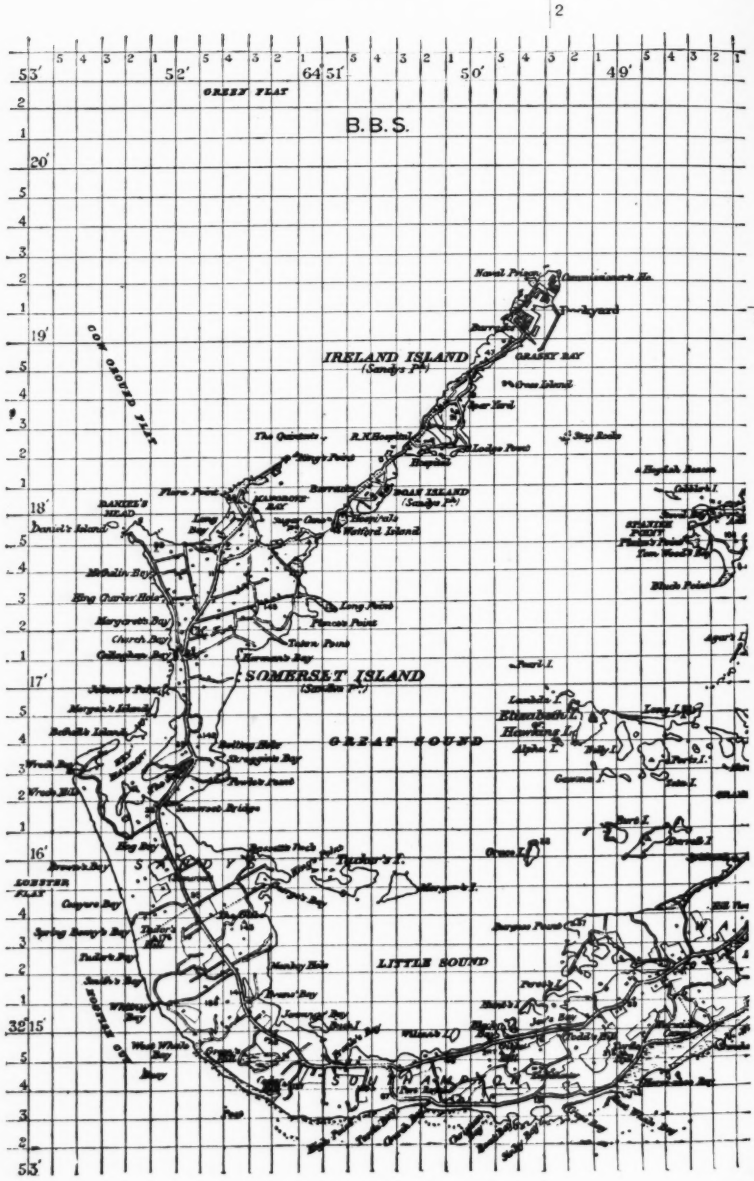
The construction of the dock is such that it is rather difficult to get satisfactory pictures of the piling. The view (Fig. 1, pl. I), however, shows something of the external evidence of destruction, caused in this case by a "shipworm."

At Agar's Island, on the other hand, the attacks on wooden structures have been due chiefly to the minute crustacean *Limnoria lignorum* (Rathke). This is the only species of this genus at present known in the western Atlantic. The stone-and-concrete wharf at Agar's Island (Fig. 2, pl. I) is protected by heavy beams; two of these, as "stringers," are bolted to the masonry, into which they are sunk a few inches; a third one, the top of which is level with the top of the wharf, is also securely anchored to the masonry and projects six or eight inches beyond the outer edge of the top stringer. This cap, together with vertical posts about ten feet apart bolted to both cap and stringers, serves as a protection, or fender, to the wharf. The posts, about eight inches square, originally had their bottom ends set in foot-plates of concrete. The wharf with its woodwork was built about 1895. The lower portions of the posts, from the bottom up to the level of high water, have now entirely disappeared. The destruction has undoubtedly been caused by Limnoria, rather than any of the several species of Teredo found in Bermuda.

But the most satisfactory evidence secured regarding the rate of

destruction by Limnoria was that got from the log-float at the mooring used for the boats of the Biological Station, situated about 150 feet east of the main landing steps at Agar's Island. This cylindrical float was spruce somewhat more than seven feet long and about eighteen inches in diameter, and was shackled to a chain running down to the bight of the bridle connecting the two anchors. The shackle attachment was such as to allow the float considerable freedom of motion around its axis, somewhat more than half of the float being submerged. As a result of this rolling motion the erosion due to the borers (Limnoria), working chiefly at or near the water line, caused the float to take on the form of an hourglass. The mooring was put down in the summer of 1907 by Mr. L. L. Mowbray, and the float was well tarred before being put overboard. Notwithstanding this protective covering, it had become reduced in diameter at the narrowest region of the hourglass to about two inches, so that an accidental collision with a steam tug caused it to break in two early in the summer of 1922. A portion of the float, suspended by the shackle, is shown in Figure 3 (pl. II). During the fifteen years that it had been uninterruptedly exposed to the action of the borers and the sea, its diameter had been reduced about sixteen inches, and its radius, of course, half that amount, so that the actual rate of erosion was a little more than half an inch per year. A somewhat greater rate of destruction has been independently inferred by Mr. Clapp (1924, These Proceedings, vol. 59, p. 280) from a study of blocks attached to four test-boards — to be described a little further on — exposed at Bermuda during the twelve months ending about August 1, 1923. His conclusion was reached before he was aware of the results shown by the mooring float.

A study of the remnant of this float (Figs. 3–8) shows that the direction of the boring by Limnoria is influenced to some extent by the alternating arrangement of the harder and softer parts of the year's growth of the wood. The softer parts are more completely tunnelled than the harder parts, the harder layers being often bored through in a direction nearly perpendicular to the surface of the "growth rings." The result is that the substance of the softer layers is so weakened by the passages bored in them that the harder layers become detached from each other by the action of the waves and hang as thin sheets of woody substance so perforated with holes as to give them a lace-like appearance (Figs. 5, 6). These perforated sheets are in time torn away, little by little, through the influence of wind and water; the animals meanwhile have bored their way into the deeper layers of the wood, which in turn undergo the same fate.


B.B.S.
GREEN FLAT
IRELAND ISLAND
SOMERSET ISLAND
GREAT SOUND
LITTLE SOUND
GOOSEBERRY BAY
LOBSTER FLAT
GRASSY BAY
DANIEL'S HEAD
Daniel's Island
Long Bay
Mangrove Bay
Church Bay
Cottonham Bay
Watford Island
Long Point
Tucker Point
Pearman Point
Turner Point
Hog Bay
Spring Bay
Tucker Bay
Smith's Bay
Whipping Bay
Mill Bay
Brown Bay
Kennedy Bay
Williams Bay
Morgan's Point
Burgess Point
Ferry I.
Nonsuch I.
Long I.
Agar's I.
Pearl I.
Ely's Harbour
Hawkins I.
Alpha I.
Gurnet I.
Turtle I.
Darrell's I.
Ordnance I.
Cooper I.
Tucker I.
Morgan's I.
Nonsuch Pt.
Flora Point
Mangrove Bay
Long Bay
Mullin Bay
Big Darrell Bay
Mangrove Bay
Church Bay
Cottonham Bay
Mangrove Islands
Buffalo Islands
Rolling Hills
Mangrove Bay
Wreck Bay
Wreck Hill
Bay Bay
Spencer's Bay
Cooper

Thus the devastation advances slowly but steadily during active boring. The borers, however, rarely penetrate more than half or three-quarters of an inch below the temporary surface of the wood (Fig. 4, pl. II). The rate at which the destruction takes place doubtless varies somewhat with the kind of wood and the abundance of the borers, but, as already stated, is probably from half an inch to an inch in the course of a year. That the temperature of the water also influences to a considerable extent the boring activities of Limnoria, is probable, though it is not so much restricted in its work by cold water as are the shipworms. The subject of temperatures and their influence on "borers" will be discussed in a future paper.

As a result of my correspondence with Colonel Atwood, I had made four test-boards, constructed after the pattern adopted by the New York office, and put each of them in charge of a responsible person. The boards were located at places fairly remote from one another, as indicated on the accompanying maps (Figs. A–C) by the numerals 0, 1, 2, 3.

The locations, surrounding conditions, names of the persons in charge of the boards, etc., were as follows:

No. 0. (Fig. B.) At *Agar's Island*, near the south landing steps of the east side of the island, in latitude 32° 17′ 12″ N., longitude 64° 48′ 02″ W.[1] The board was submerged on July 16, 1922, in water about 12 feet deep at low tide, the bottom of the board resting on the sea bottom. Mr. Antony Cabral had charge of it. There was a gentle flow of water past the board with each turn of the tide.

No. 1. In *Bar's Bay*, Hamilton Harbor, near Mr.Wainwright's boat landing. Lat. 32° 17′ 02″ N., long. 64° 46′ 52″ W. (Fig. B.) Board installed August 1, 1922, by Mr. Harley G. Spurling — who was in charge of it — in water about 12 feet deep at low tide, in a protected spot where there was not a strong current.

No. 2. At the *Navy Yard*, Ireland Island, "at the northwest corner of the North Basin, close to one of the open-sea inlets, where there was a good flow of changing water." Lat. 32° 19′ 12″ N., long. 64° 49′ 28″ W. (Fig. A.) The board was placed in water 8 feet deep at low spring

[1] The latitude and longitude here given for each of the four stations correspond with the latitude and longitude of the maps accompanying this paper (Figs. A–C), which are based on the map of Bermuda published by the Ordnance Survey, Southampton, 1901; but the true latitude is approximately 16″ greater than that of the maps. For the explanation of the discrepancy, see J. F. Cole: "Magnetic Declination and Latitude Observations in the Bermudas." Terr. Magn. and Atmosph. Electr., Vol. XIII, No. 2, pp. 49–56. June, 1908.

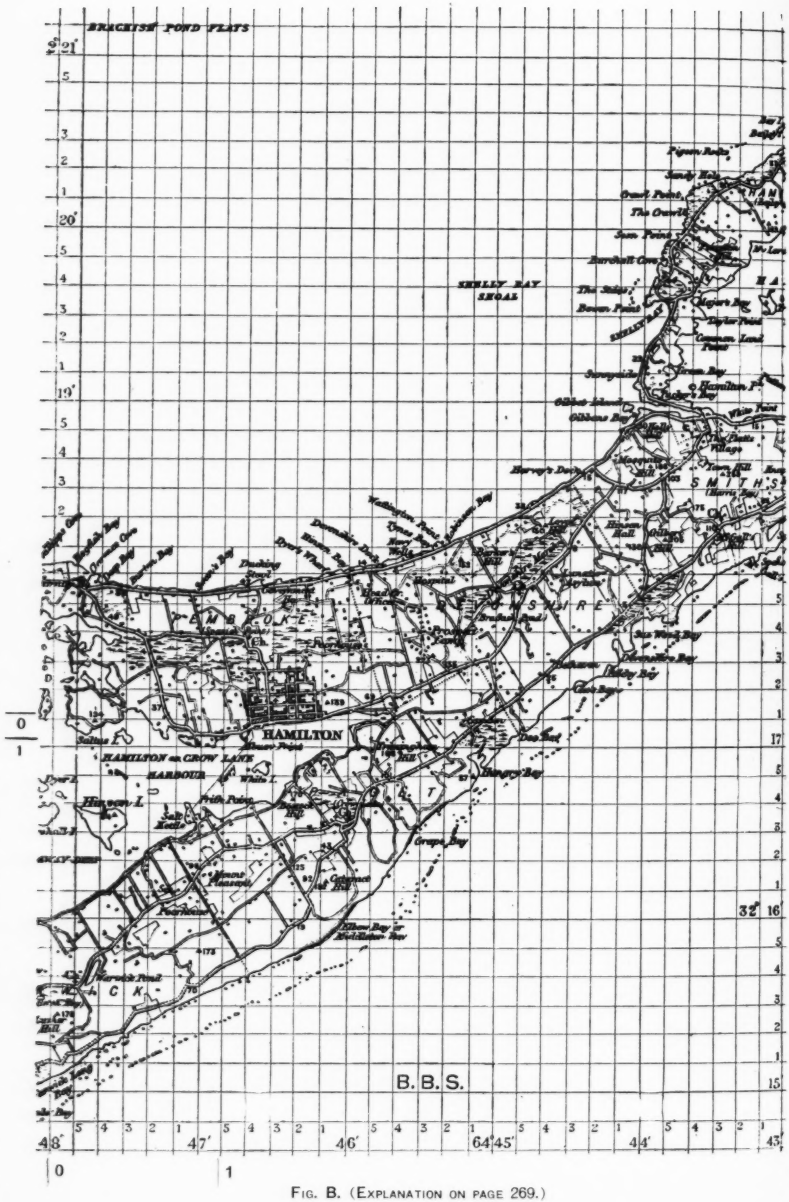


FIG. B. (EXPLANATION ON PAGE 269.)

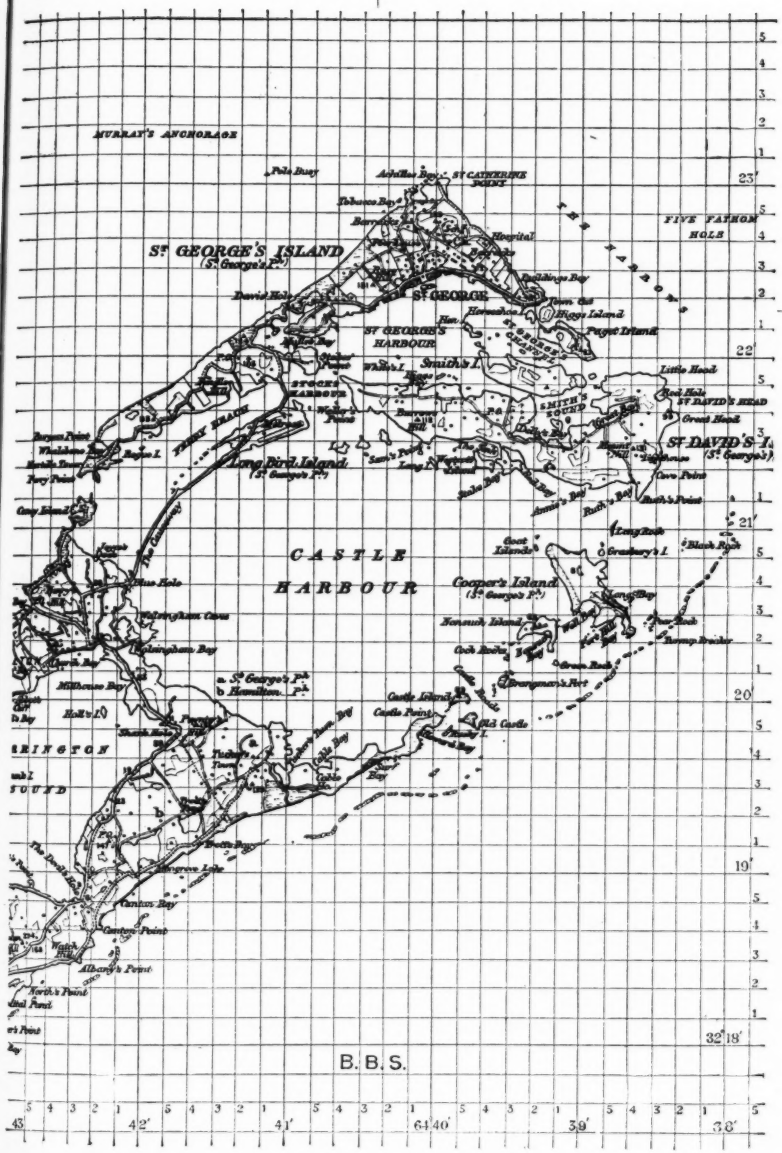


FIG. C. (EXPLANATION ON PAGE 269.)

tide, on August 2, 1922, under direction of the "Captain in charge," at the Navy Yard, Lieut. A. B. Baker, who kindly consented to look after the matter.

No. 3. In *St. George's Harbor,* at the boat landing of R. S. McCallan, Esq., who generously took charge of this board. Lat. 32° 22′ 16″ N., long. 64° 40′ 25″ W. (Fig. C.) The board was submerged July 31, 1922, in water 8 feet deep at low tide.

To each of those who took charge of a test-board I am much indebted, and especially to Mr. McCallan and to the officers of the Navy Yard,— Lieutenant Baker and his successor, Lieutenant F. H. Bishop,— who gave their services gratuitously.

The construction of the test-board, a fuller account of which is given by Mr. Clapp in the article immediately following this, is seen in Figure D, which shows, at the left, a face view of the completed board, and at the right an edgewise view. The wood used in the Bermuda test-boards was spruce, the most satisfactory available material. The twenty-four blocks were numbered by chiseling on the exposed (4″x 5″) face Roman numerals from I to XXIV,[2] and they were attached to the board in sequence (beginning at the top of the board, twelve on a side), each by means of two countersunk brass screws. Experience showed that there was some danger of the numbers being destroyed or obscured by borings and incrustations, so that the replacement blocks, those used after the first set of 24, were numbered on the face in contact with the board as well as on the exposed face.[3]

The procedure with each of the four boards after installment was substantially the same. At approximately regular intervals of about two weeks, varying somewhat according to the sailing dates of the mail steamers, the numbered blocks were removed from the board in sequence, one at a time, beginning with number one, and a new block screwed on in place of the one removed. The detached block was

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2 The numbered coppered disks at first employed by the Committee proved to be unsatisfactory.

3 As considerable difficulty was experienced in getting the Teredos out of the thick "blocks" in an uninjured condition, it was suggested by Mr. Clapp that the use of a bundle of shingles firmly bound together would probably solve the difficulty. In place of shingles, however, I used pine slats a quarter of an inch thick, three inches wide, and fifteen inches long. Thirteen or fourteen of these slats were bolted together in a bundle by means of two 5-inch eye-bolts made of quarter-inch galvanized iron. The bundle was lashed to the edge of the original test-board by boring holes near the edge of the board and passing the lashings through these holes and the bolt-eyes, as shown in Figure E.

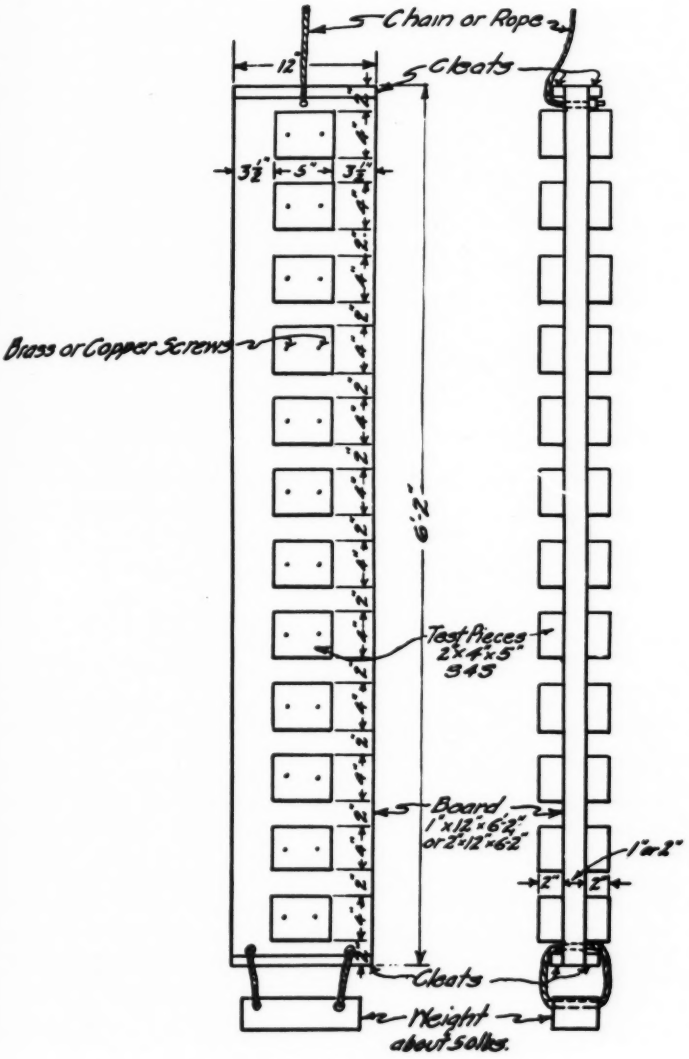


FIG. D. (EXPLANATION ON PAGE 269.)

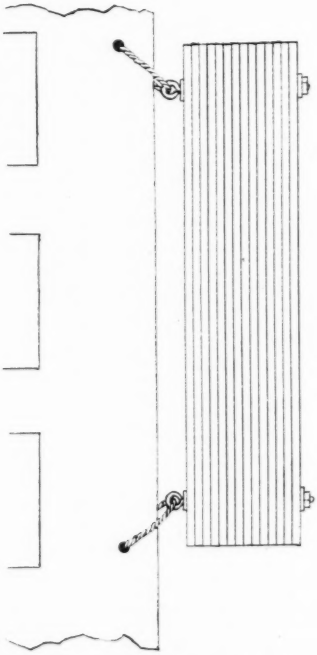


FIG. E. (EXPLANATION ON PAGE 269.)

wrapped in many layers of paper and sent by parcels post to Cambridge for study by Mr. W. F. Clapp.

The plan contemplated the shipment of the original twenty-four blocks during the first twelve-months' exposure of the board, and if the board should last for another twelve months, the shipment of the twenty-four replacement blocks.

One of the results of Mr. Clapp's study of the Bermuda blocks has been the discovery of two species of "shipworms" which are new to science, and a third which is possibly so. His descriptions of these three species are given in the number of these Proceedings immediately following the present one.

EXPLANATION OF TEXT FIGURES.

FIGURE A. One of three maps which together include the whole of the Bermuda Islands. The location of test-board No. 2 is indicated on this map by the place where the two short lines outside the map, marked by the numeral 2, would intersect, if continued.

FIGURE B. Map of the middle portion of the Bermuda Islands, to show the location of test-boards No. 0 and No. 1, indicated as in Figure A.

FIGURE C. Map of the northeastern portion of the Islands, to show the place of test-board No. 3.

FIGURE D. Face view (left) and edgewise view of test-board, giving dimensions of parts.

FIGURE E. Face view of a part of a test-board with a bundle of slats, seen edgewise, lashed to it.

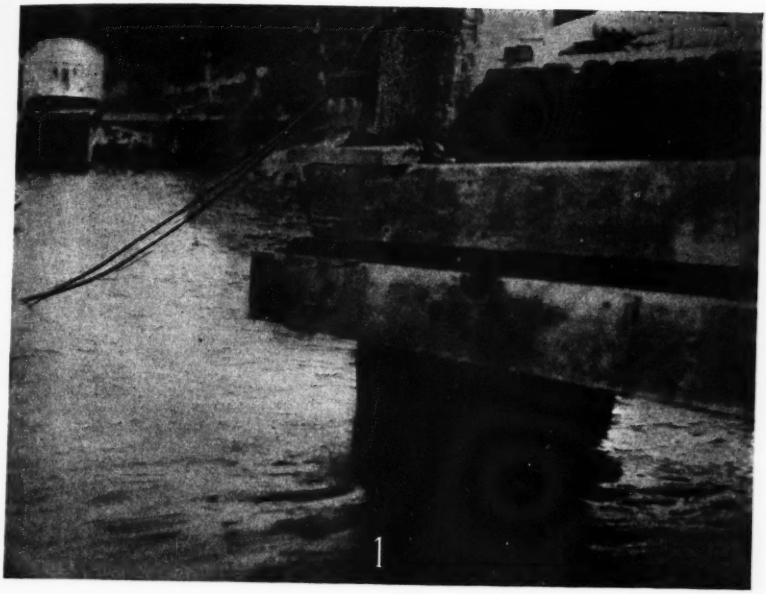
EXPLANATION OF PLATES.

(The photographs from which Figures 1–6 were reproduced were taken by Mr. A. J. Lanchner.)

PLATE I.

FIGURE 1. View of a corner of Mr. H. C. Master's dock in Pitt's Bay, showing that the inner one of two piles is half eaten away near the surface of the water. Photograph taken at about half tide. See text.

FIGURE 2. View of a part of the landing dock at Agar's Island, showing that the lower ends of all the vertical posts have been destroyed (by Limnoria) up to the level of high water.

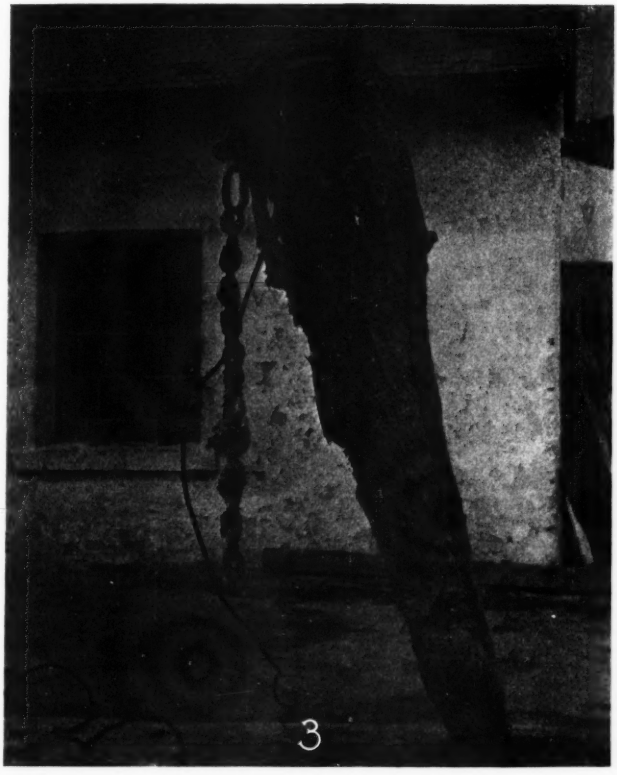

1

2

PLATE II.

FIGURE 3. Portion of log-float of mooring at Agar's Island, suspended by the shackle, to which a part of the heavily encrusted anchoring chain is still attached. The wire cable was attached to the shackle in 1921, and secured to a temporary float, to prevent the possible loss of the original log-float.

FIGURE 4. Freshly cut surfaces of the log-float exposed by sawing the float in two about 18 inches from the broken-off end. The D-shaped cross section measured 7 inches by 11 inches, and shows the slight depth to which the Limnoria bores. A knot, protruding in the middle of the flattened face of the right-hand portion, shows that it has resisted the attack of Limnoria.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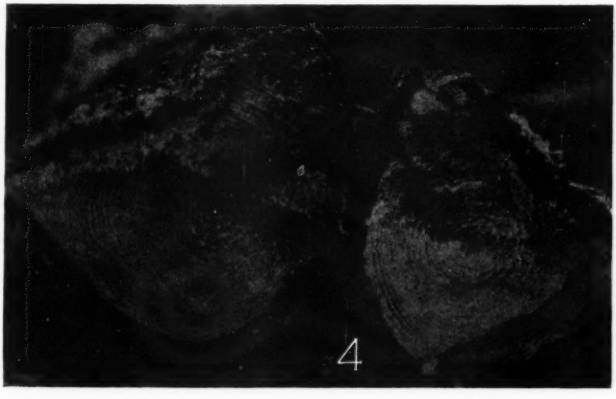
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PLATE III.

FIGURE 5. Profile view of one side of log-float to show the lace-like appearance of the detached hard-wood laminae.

FIGURE 6. Surface view of a portion of the float, showing the richly perforated overlapping sheets of the harder wood.

5

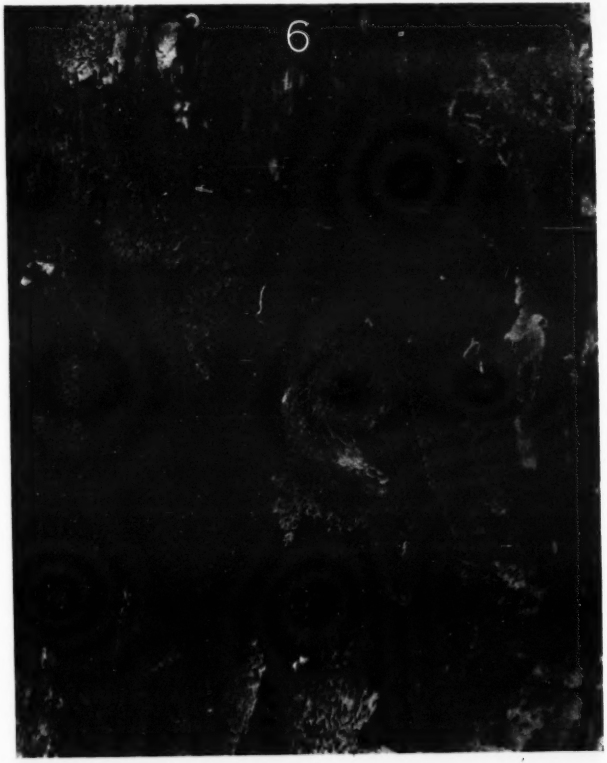
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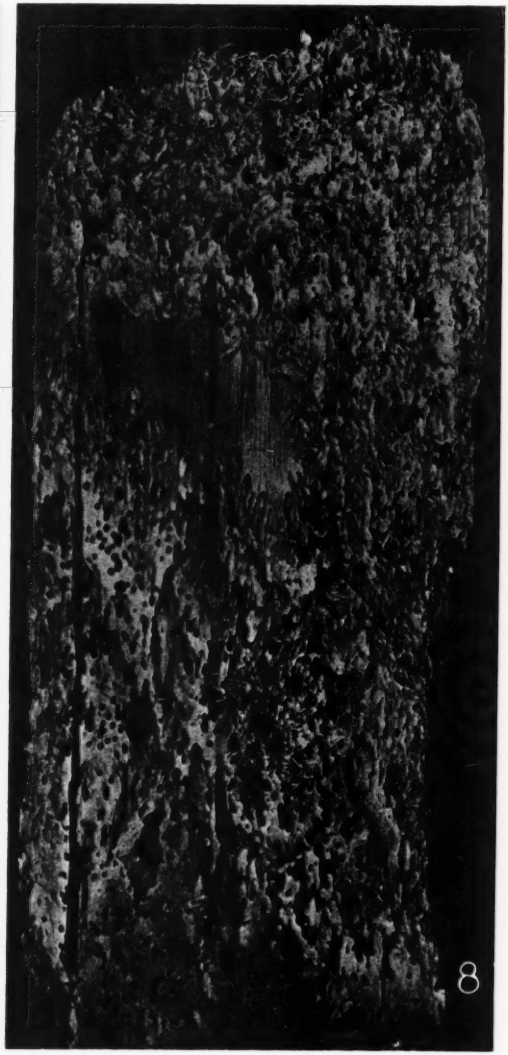
PLATE IV.

FIGURE 7. A split-off portion of the log-float seen edgewise, to show the lamination of the bored region and its relation to the annual rings of growth. In a few places in the deeper portions of the wood, next to the unbored parts, a dried-up borer, as a whitish object, may be seen in its burrow.

FIGURE 8. Face view of the same piece of wood as shown in Figure 7, seen from the face that is at the left in Figure 7. A few laminae, in the upper half of the figure, have been removed so as to show the tortuous courses of the borings in the softer wood.

7



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Proceedings of the American Academy of Arts and Sciences.

Vol. 59. No. 12.— May, 1924.

CONTRIBUTIONS FROM THE BERMUDA BIOLOGICAL STATION FOR RESEARCH. No. 143.

NEW SPECIES OF SHIPWORMS IN BERMUDA.

By W. F. Clapp.

With Three Plates.

UNIV OF MICH.

CONTRIBUTIONS FROM THE BERMUDA BIOLOGICAL STATION FOR RESEARCH. NO. 143.

NEW SPECIES OF SHIPWORMS IN BERMUDA.

By W. F. Clapp.

Received March 29, 1924. Presented by E. L. Mark, November 14, 1923.

A preliminary investigation of the activities of shipworms and other borers at Bermuda was begun in the summer of 1922 by Dr. Mark, Director of the Bermuda Biological Station for Research.

A study of the destruction caused by wood-boring marine organisms in the coastal waters of the United States, under the direction of the Committee on Marine Piling Investigations of the National Research Council, had already been under way for some months. In order that precise information regarding the destructive organisms might be obtained systematically, a special test-board had been designed by the Committee (cf. Mark, 1924, p. 267, Fig. D). Each board was 6 feet long, 12 inches wide and 1 inch thick. Twenty-four numbered blocks, each 2 by 4 by 5 inches, were attached consecutively 2 inches apart on the two faces of the board, 12 on a side. Every two weeks after the test-board was submerged, it was taken from the water and one block after another in regular sequence was removed and sent to the author at Cambridge for examination; a new numbered block being installed in place of the one removed. For a further description of test-boards used and the method of handling the blocks, consult Clapp (1923) and Mark (1924). Early in the year 1922 many such test-boards were submerged by the agents of the Committee at various stations along the Atlantic and Pacific coasts, and they were already furnishing important information.

Dr. Mark, desiring to coöperate with the Committee, installed similarly constructed test-boards at four stations in Bermudan waters, and has given an account of them, and of the places of their installment, etc. (cf. Mark, 1924).

At none of the four stations could the attack by shipworms be considered severe when compared with the destruction caused by the same species at Key West, Florida, and in the West Indies. Few of the one hundred or more blocks received contained more than thirty or forty specimens of Teredo. The attack on the wood by Limnoria

during the same period of time was of such severity that the posterior ends of the shipworm tubes were soon exposed to the action of the water. This resulted in the premature death of many of the shipworms; possibly this may account for the fact that specimens of large size were rare. The destruction caused by Limnoria at the four stations was found to be approximately at the rate of one inch in twelve months (cf. Mark, 1924, p. 261). The blocks exposed at Bermuda presented conditions very similar in appearance to those submerged for the same length of time at Key West, Florida, not only as regards the severity of the Limnoria attack and the light destruction caused by the shipworms, but also in respect to the associated organisms found on the surface of the wood, particularly the bryozoans and serpulas. In each of the four cases the boards were exposed under somewhat similar conditions, due especially to the fact that they were in more or less sheltered places. Judging from an examination of driftwood from Bermuda — the exact locality, of course, unknown — there is much reason to believe that at more exposed locations the shipworm attack would be found to be much more severe.

Among the shipworms received in the test-blocks were three species of Teredo which have not been previously described. The description of two of these species, *Teredo* (*Teredo*) *batilliformis* and *Teredo* (*Zopoteredo*) *somersi*, will be found in the following pages. *T. batilliformis* is the only species which has not been found elsewhere than at Bermuda. *Teredo somersi* has occurred in test-blocks at Santo Domingo, Haiti, and the Virgin Islands, and also, in considerable numbers, in southern Florida at Key West and Channel Five. The third species, one belonging to Teredo *s. s.*, and still to be described, has even a wider distribution, being found at the localities mentioned for *T. somersi* and in addition, at Guantanamo, Cuba; in Porto Rico; and at Coco Solo, Panama, at all three of which regions it is plentiful. It is closely related to, if not identical with, a species which we have found in test-blocks submerged at Pearl Harbor, Hawaiian Islands, and also in blocks from Cavite in the Philippine Islands. Bartsch (1921, p. 28) had already described as *Teredo parksi* specimens collected in Pearl Harbor, Hawaii. Desiring Dr. Bartsch's opinion regarding the relationship between the Pacific and the Atlantic forms, I sent to him material from all our sources and he has very kindly compared the undescribed Atlantic form with the type of *Teredo parksi*. From a study of the limited amount of material at hand, he thinks that the two cannot be considered cospecific. I have, therefore, refrained for the present from considering this widely distributed

Atlantic form as identical with *T. parksi*. Not until it is possible to obtain more material and to devote more time to a thorough study of the two forms can the question be answered satisfactorily.

In addition to the undescribed species mentioned above, there also occurred in the test-blocks from Bermuda the following previously described species.

Teredo (Teredora) thomsoni Tryon.

Large specimens of this species occurred in many of the test-blocks from Ireland Island. Since they were found only in the blocks near the top of the board, it seems probable that the embryo of this species is more of a surface swimmer than are the embryos of the other species found in Bermuda. A careful comparison of the specimens of this species from Bermuda with specimens from the text-blocks at Key West, Florida, shows them to be identical.

Teredo (Zopoteredo) clappi Bartsch (1923[a], p. 96).

This species, described by Bartsch from Key West, is one of those most commonly found in Bermuda, occurring plentifully at Bar's Bay and at St. George's. It was also common in the test-blocks from Key West, Florida; Cuba; Haiti; Santo Domingo; Porto Rico; and Coco Solo, Panama.

In addition to the above, one test-block from Agar's Island contained forty or more specimens of a species of shipworm belonging to the genus *Lyrodus*. Careful examination failed to show any specimens of this species in any of the other blocks from Agar's Island, and no specimens were found in the test-blocks from any of the other Bermudan stations. Specimens identical with these were found, however, in test-blocks from three different boards at Key West, Florida. A larger series might possibly prove that this species is the same as that described by Jeffreys (1860, p. 123) as *Teredo* (*Lyrodus*) *bipartita*.

It is remarkable that all of the six species of shipworms found at Bermuda belong to the genus Teredo, and that the genus Bankia (Xylotria) should not be represented, either in the collections of the present investigation or in any previous records. Of the six species at Bermuda, five are also found in southern Florida, and of these five, at least three, and possibly four, are also found at numerous localities in the West Indies.

To aid in following the technical descriptions of Teredos, Figure A is here introduced.

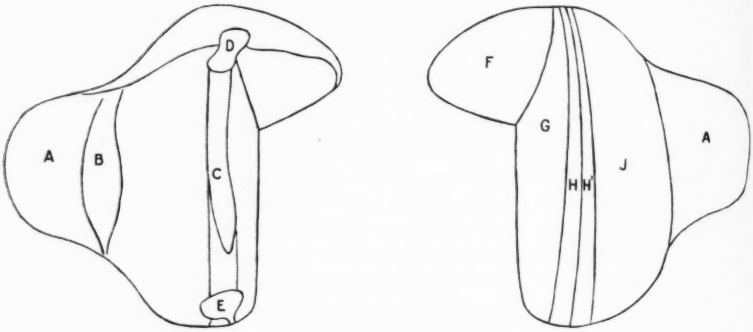

FIGURE A. A, Auricle or Posterior part; B, Shelf; C, Apophysis or Blade; D, Dorsal articulation or Dorsal knob; E, Ventral articulation or Ventral knob; F, Anterior area; G, Anterior-median area; H, Middle-median area, anterior part; H′, Middle-median area, posterior part; J, Posterior-median area.

TEREDO (TEREDO) BATILLIFORMIS,[1] sp. nov.

(Pl. I, figs. 1–6; Pl. III, figs. 13, 14.)

Shell subglobular, white, covered with a thin horn-colored periostracum. The anterior area joining the anterior-median area in a slightly curved incised line. The ventral edge of the anterior area curving downward and backward, but forming with the anterior edge of the anterior-median area an angle of only slightly more than 90°.

Externally, the anterior area with the usual denticulate ridges. These ridges are one half as wide as the intervening spaces. Beginning at the ventral posterior edge, there are ten of these denticulate ridges to the millimeter, each ridge bearing eighty denticles to the millimeter (Pl. III, fig. 13). The width of the anterior-median area, at a point opposite the ventral edge of the anterior area, slightly less than one third that of the entire median area. The denticulate ridges on this area average twenty-six to the millimeter, counted along a line extending from the ventral edge of the anterior area perpendicular

[1] From *batillum*, a shovel, referring to the shovel-shaped pallet, a name suggested by Dr. Mark.

to the ridges. In the type specimen there are fifteen of these ridges, each bearing about twenty-eight denticles to the millimeter (Pl. III, fig. 14). The denticles on the ventral ends of these ridges end abruptly where the ridges, as faint growth lines, bend backward over the anterior portion of the middle-median area. The posterior portion of the middle-median area, thin, transparent, slightly concave. The posterior-median area opaque, milk-white, considerably more than half as wide as the entire median area; its posterior half marked by narrow deeply incised growth lines, dividing this part of the shell into regularly spaced broad ridges. The auricle small and semi-transparent, excepting the outer edge, which is milk-white. Where the anterior margin of the auricle meets the posterior-median area, the latter presents a narrow shoulder, but this does not prevent tracing, on the auricle, the growth lines, which there appear as narrow, transparent, concentric threads.

Internally, the left valve with a very large broad hinge-plate. In both valves the blade two thirds of the length of the shell, thin, the dorsal part narrow, the middle and ventral portions broadened and slightly reflected posteriorly. The ventral knob large. The juncture of the anterior area with the anterior-median area marked by a broad, thick, transparent callous. The auricle extending over the posterior-median portion in a broad, thick, opaque callous, ending in an abrupt ridge, but lacking any trace of a shelf or overhang.

Pallets (Pl. I, figs. 5, 6) with a broad, nearly square blade, which envelops with a thin sheath a long, very slender stalk. The proximal portion of the blade white, arising from the stalk in an abrupt curve. The calcareous portion extends to the extreme distal end of the blade, the distal two thirds of which is covered with a yellowish horn-colored periostracum. The inner face of the blade flat, the distal edge nearly straight. The outer face slightly convex, its distal portion with a broad shallow depression.

The posterior end of the shelly tube with two long, narrow ridges, arising from opposite (lateral) sides of the internal surface; the wall greatly thickened at the base of these ridges and continuing beyond the rest of the shelly portion of the tube as sharp points.

The type specimen (Mus. Comp. Zoöl. 45305) is from St. George's, Bermuda.

The measurements of the type are:

Shell: height 4 mm.; length 3.75 mm.

Pallets: entire length 3.7 mm.; length of stalk 2.1 mm., of blade 1.6 mm.; width of blade 1.3 mm.

It is very difficult to separate the *shell* of *Teredo batilliformis* from that of other closely related species of Teredo. From *T. portoricensis* it may usually be distinguished because possessing a proportionately larger anterior area. The ventral edge of the auricle forms a less abrupt angle with the posterior-median area than in *T. portoricensis*. The broad flat hinge-plate is much larger, and the blade proportionately longer. The juncture of the auricle with the posterior-median area is less well marked. The internal ridges of the posterior end of the tube are considerably longer than is usual in *T. portoricensis*.

The *pallets* are very different from those of any previously described species, the delicate stalk and the broad, squarish blade being so dissimilar to those of other species of the subgenus Teredo that I place this species here with some doubt.

T. batilliformis has been found only at Bermuda. It has occurred at frequent intervals in test-blocks at all four of the stations (Agar's Island, Bar's Bay, Ireland Island and St. George's) established there. A test-block submerged at Agar's Island in August, 1922, and removed January 1, 1923, contained, among others, one specimen with a tube 35 mm. in length and holding in the gills about one hundred fully developed embryos. The first specimens to be found appeared in the test-blocks at all four stations simultaneously in the latter part of December. None attained a total length of more than 60 mm., and no specimens contained more than one hundred embryos in the gills.

Teredo (Zopoteredo) somersi,[1] sp. nov.

(Pl. II, figs. 7–12; Pl. III, figs. 15, 16).

Shell subglobular, white, covered with a transparent, colorless or very light horn-colored periostracum. The anterior area with the usual denticulate ridges. The juncture of the anterior with the anterior-median area marked by a curved, slightly incised line. The ventral edge of the anterior area forming an angle of 100° or more with the anterior edge of the anterior-median area. On the ventral posterior portion of the anterior area the denticulate ridges of approximately the same width as the intervening spaces. Dorsally, the intervening spaces only a very little wider than the denticulate ridges. At the ventral portion there are twelve of these ridges to the milli-

[1] Named from "Sir George Somers, Knight, Admirall of the seas," who has been called the "Father of Bermuda." This name also was suggested by Dr. Mark.

meter, each ridge bearing one hundred and ten minute denticles to the millimeter (Pl. III, fig. 15). The anterior-median area occupies slightly more than one third of the entire median area. The broadest portion of this area — at the level of the ventral edge of the anterior area — bears seventeen of the usual denticulate ridges, which average thirty-five to the millimeter; the anterior ridge bears thirty-two denticles to the millimeter (Pl. III, fig. 16). The posterior-ventral ends of these ridges can be faintly seen as growth lines passing backward over the middle-median area, quickly disappearing on the posterior-median area, which is nearly smooth. The auricle is small, its outline nearly semicircular and its juncture with the posterior-median area perceived only with difficulty.

Interiorly, there is the usual broad, flat hinge-plate in the left valve directly beneath the umbone. The apophysis, curving downward and backward for slightly more than one half the length of the shell, narrow and thin, excepting at its extreme ventral portion, where it is considerably broadened. The concave surface of the blade reflected posteriorly. The juncture of the auricle with the posterior-median area having no trace of a shelf, but marked by a broad, thickened area, with a narrow groove at its anterior edge.

Pallets (Pl. II, figs. 11, 12) very strong and solid. The stalk short, thick, opaque-white, equal in length to the blade. The juncture of the stalk with the sheath of the blade abrupt and well marked, owing to the much larger diameter of the sheath. The blade calcareous, white, expanding from the stalk by a broad regular curve, the distal half covered by a nearly opaque, heavy, smooth, closely fitting periostracum of light horn-color. Only the chitinous horns at the extreme distal end of the blade lacking the calcareous substance. The sides of the blade converging slightly distally. Inner surface of the blade very slightly concave, outer surface convex, deeply cupped at the distal end, the outer face somewhat less deeply cupped than the inner.

The posterior end of the tube with a very short, thin, horizontal partition, dividing the tube into equal parts. The tube greatly thickened on each side at the base of the partition.

The type specimen (Mus. Comp. Zoöl. 45304) is from Ireland Island, Bermuda. There are also in the U. S. National Museum additional specimens from the type locality.

The measurements of the type are:

Shell: height 3.2 mm.; length 2.8 mm.

Pallets: length 2.9 mm., divided equally between blade and stalk; width of blade at widest portion 1 mm.

The shell of *Teredo somersi* can be separated from that of *Teredo (Zopoteredo) clappi* Bartsch (1923[a], p. 96) only with great difficulty. I have placed this species in the subgenus Zopoteredo because it has at the juncture of the auricle with the posterior-median area the structure typical of that subgenus. From *Teredo clappi*, however, it may usually be distinguished by the fact that the angle made by the ventral edge of the anterior area with the anterior edge of the anterior-median area is more obtuse. On the anterior area of *T. clappi* there are eighteen denticulate ridges to the millimeter, whereas in *T. somersi* there are usually only twelve. On the anterior-median area, the denticulate ridges are narrower in *T. somersi* than in *T. clappi* (*T. somersi* thirty-five, *T. clappi* twenty-eight to the millimeter), but the denticles on these ridges are considerably broader (*T. somersi* thirty-two, *T. clappi* forty to the millimeter).

The pallets of *T. somersi* are very different from those of *T. clappi*, the most important difference being that those of mature specimens show no trace of the sinus, or double cup, characteristic of *T. clappi*. Pallets of very young specimens, however, clearly show this sinus.

The entire length of the tube rarely exceeds fifty millimeters, and specimens less than fifteen millimeters in length frequently contain well developed embryos in the gills. The number of embryos in an individual is small; no specimen examined contained more than seventy-five, and small specimens had, in an apparently full litter, not more than twenty to twenty-five. Possibly because of this fact, the species is rare and the damage caused by it practically negligible.

Specimens of this species have been found not only at Bermuda, but also in the test-blocks placed by the Committee on Marine Piling Investigations at the following locations: Channel 5 and two stations at Key West, Florida; San Pedro de Macrois, Santo Domingo; Port au Prince, Haiti; and Christiansted, St. Croix, Virgin Islands.

In Bermuda, test-blocks placed at Agar's Island, Bar's Bay, Ireland Island, and St. George's, all contained specimens of this species at irregular intervals. The first specimens found occurred in test-blocks placed in the water August, 1922, and removed January 15, 1923. No blocks removed before that date contained any specimens of this species.

Specimens from Florida and the West Indies are generally smaller than those from Bermuda; however, one specimen in wood from the Virgin Islands had a tube length of one hundred millimeters. Stenomorphic (Bartsch, 1923[b], p. 330) specimens are frequent in all localities.

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EXPLANATION OF PLATES

Figures 1-12 (Plates I and II) are each magnified 14 diameters; those of Plate III (Figures 13-16) 130 diameters.

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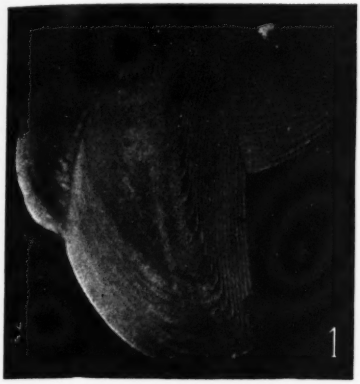
PLATE I.

TEREDO BATILLIFORMIS, sp. nov. Type.

FIGURE 1. Exterior of right valve.
2. " " left "
3. Interior " left "
4. " " right "
5. Pallet, outer face.
6. " inner face.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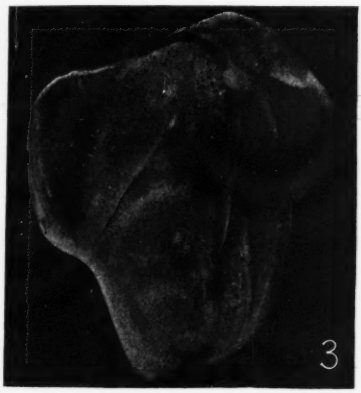
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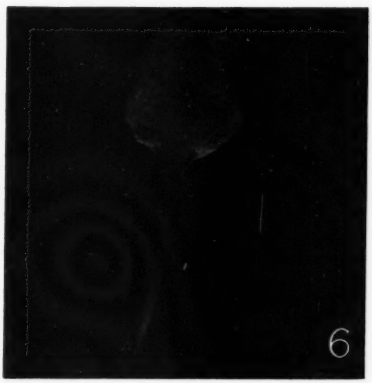
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PLATE II.

TEREDO SOMERSI, sp. nov. Type.

FIGURE 7. Exterior of right valve.
8. " " left valve.
9. Interior " left "
10. " " right "
11. Pallet, outer face.
12. " inner "

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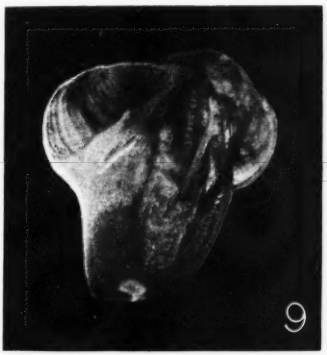
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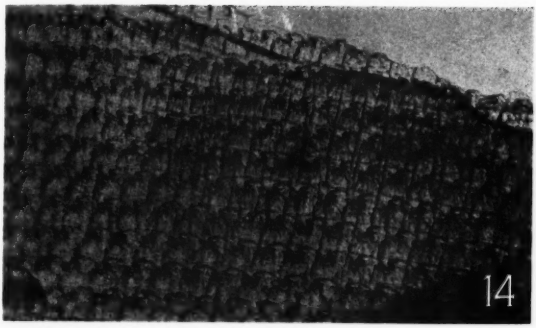
PLATE III.

FIGURE 13. Teredo batilliformis, denticulate ridges, anterior area.
14. Teredo " " " anterior-median area.
15. Teredo somersi, denticulate ridges, anterior area.
16. Teredo " " " anterior-median area.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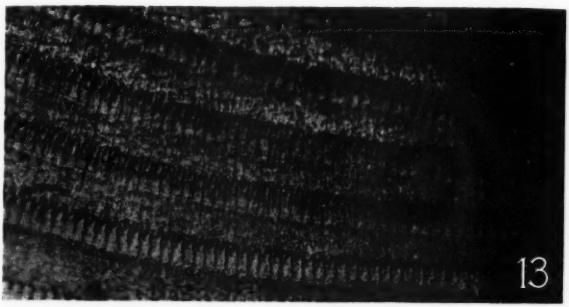
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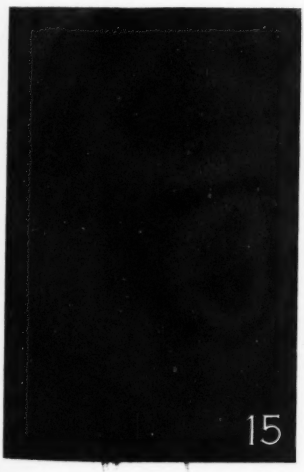
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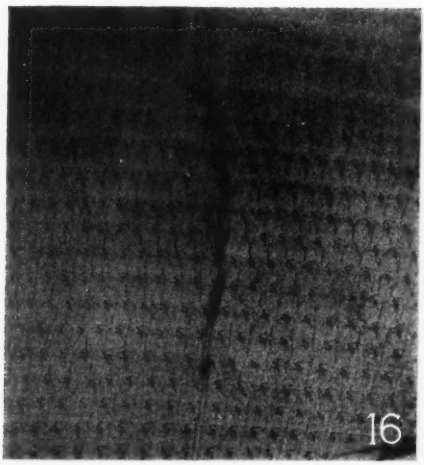
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